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UPPER NOTUKEU CREEK BASIN

HYDROLOGY STUDY

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SYNOPSIS

The Notukeu Creek Basin above Gouverneur Reservoir is a relatively dry agricultural area in southwestern Saskatchewan. In addition to Gouverneur, two upstream reservoirs, Admiral and Cadillac, provide storage capacity in the basin for water development use.

The present study included an evaluation of runoff potential in the basin, and of annual draft which would be available from each of the three above-mentioned reservoirs under given conditions of upstream demand and reservoir operation.

In the analysis of draft for Gouverneur Reservoir, allowance was made for the effect of water use and operation on the two upstream reservoirs. Spillage from these reservoirs, under the given conditions, was routed downstream as partial inflow to Gouverneur Reservoir.

The study indicated that the setting of minimum or maximum operating levels in a reservoir, which affects the volume of live storage, is an important factor in determining the magnitude of available annual draft. It was also found that changes could be made in the upstream demand , draft use and operation of the two upstream reservoirs without seriously depleting the water supply for Gouverneur Reservoir.

Chapter I

INTRODUCTION

Notukeu Creek is a fairly typical prairie stream, which rises in the general area immediately to the east of Shaunavon. It follows a more or less easterly course to its confluence with the Wood River just north of Gravelbourg. Throughout its considerable length the creek traverses an often water short agricultural area of southwest Saskatchewan.

In an effort to improve the available water supply, storage reservoirs were built by PFRA at suitable sites in the upper basin. The largest of these, Gouverneur Reservoir located on the main stem west of Ponteix, was completed in 1952. Upstream of Gouverneur, two reservoirs had already been completed, namely Admiral in 1949 also on the main stem, and Cadillac in 1945 on tributary Bull Creek.

Since construction of these reservoirs considerble use of water in the upper part of the basin has developed. In recent years there have been requests for authorization of additional irrigation development, which would involve diversion from Gouverneur Reservoir. So far these requests have been rejected by the Water Rights Branch, on the basis that the existing demand requires all the available water in the reservoir. However, a different opinion has been expressed by those requesting the additional development,

namely, that available water is not being used beneficially and that actual water requirements of the present users is significantly less than the projected demand.

In a memo to the Hydrology Branch dated September 1, 1978, with reference to an earlier July 25, 1978 memo to S.R. Blackwell, the Water Rights Branch requested that a water supply study of Notukeu Creek above Gouverneur Reservoir be carried out. The primary objective would be to estimate the available supply of water in Gouverneur Reservoir under different demands and various operating conditions. Since the water supply is affected by the operation and water use from Cadillac and Admiral Reservoirs, it was requested "that these reservoirs be considered in this study with regard to their individual drafts under different alternatives of demand and the associated effects on Gouverneur for evaluating different options."

The request pointed up the need for a full hydrology study of Notukeu Creek above Gouverneur Reservoir. Such a study would have to include an examination of the various drainage areas and estimation of annual runoff, after which allowance would be made for the effects of storage and diversion both upstream of, and at each of, the three above-mentioned reservoirs.

Chapter II

RUNOFF POTENTIAL

A. DRAINAGE AREAS

The basin tributary to Notukeu Creek above Gouverneur Reservoir is an upland area which lies east of the main body of the Cypress Hills. A map which indicates various locations and natural features within this basin, is shown on Figure 1.

Natural vegetation in this mainly farming and ranching area can be described as short grass, open prairie. Soils are generally medium in texture, with a strip of heavier textured soils running across the northern part of the basin to as far east as Crichton.

Notukeu Creek proper has its origin in Notukeu Lake, located north of Instow. However, upstream of Notukeu Lake, Grassy Creek drains an area which extends southward to Township 5 but part of which lies just east of Shaunavon. There are two other main tributary creeks in the basin. Bull Creek coming in from the southwest has its confluence with Notukeu Creek immediately downstream from Cadillac Reservoir near Cadillac. Wise Creek, a tributary of Bull Creek, contributes runoff from a sizeable area to the south.

For study purposes the drainage area above Gouverneur Reservoir was divided into three sub-basins, each tributary to a reservoir and identified by number as follows: No. 1 sub-basin tributary to Admiral Reservoir, No. 2 sub-basin tributary to Cadillac Reservoir, and No. 3 sub-basin being the local area lying downstream of sub-basins 1 and 2, and tributary to Gouverneur Reservoir.

The drainage area for these sub-basins was estimated using 1:50 000 topographic series maps and aerial photos. In all three sub-basins the effective drainage area was found to be rather large in relation to the total or gross area, as shown in Table 1, and, as indicated, wet and gross drainage areas were considered to be identical.

Table 1

DRAINAGE AREAS IN UPPER NOTUKEU CREEK BASIN

Sub-Basin Number	Effective Drainage Area Sq. Miles	Km^2	Gross (and Wet) Drainage Area Sq. Miles	Km^2
1	154	398	200	518
2	151	392	219	567
3	84	216	90	233
TOTALS	389	1006	509	1318

Drainage area boundaries for the basin as a whole, and for the three sub-basins, are shown on Figure 1.

B. RUNOFF VOLUMES

Calculated inflows, starting in 1960, to each of Admiral, Cadillac and Gouverneur Reservoirs were obtained from the Swift Current office of PFRA. These values were based on reservoir levels and gate openings for a given period during each spring runoff event, including the effect of upstream storage. In addition, the Water Rights Branch had estimated annual use upstream from each reservoir during the same time period. By combining the appropriate figures, a set of "best estimate" natural inflows to Gouverneur Reservoir for each year during the 1960-78 period was obtained.

In order to check runoff rates, and to extend the study period to include years prior to 1960, consideration was given to the available streamflow records for hydrometric stations in the area. Records of annual runoff, starting in 1975, were available for one location within the study area, Notukeu Creek above Admiral Reservoir. While these records were useful in the study for comparative purposes, it was necessary to go outside the study basin for a satisfactory source of data for estimating runoff over a longer period.

For the upper part of the adjacent Swift Current Creek Basin, there are two sets of hydrometric records which together cover a 35 year period starting in 1944. Streamflow in Swift

Current Creek was measured at the former station above Duncairn Reservoir from 1944 through 1954, and at the present station below Rock Creek starting in 1955. The flow record for the Rock Creek station was extended back to and including 1944 by allowing for the difference in drainage area between the two stream locations.

With considerable hydrologic similarity between the two basins it was considered that the Swift Current Creek records would provide a sound basis for estimating runoff in Notukeu Creek above Gouverneur Reservoir.

A graphical correlation based on the years of common record, 1960-1978 inclusive, was used to estimate runoff volumes for the missing years of record back to and including 1944. The similarity of the upper Swift Current and Notukeu Creek basins was, in fact, borne out by the consistency of points plotted for the graphical correlation.

The estimated and recorded natural runoff volumes for Notukeu Creek at Gouverneur Reservoir for the period 1944 to 1978 inclusive were tabulated, and a plotting position assigned to each value based on its relative magnitude. A frequency curve for these volumes was drawn on Gumbel probability paper for which only the figures for years of partial record, 1960-1978 inclusive, were plotted. Runoff volumes for Notukeu Creek at

Gouverneur Reservoir were then used to estimate runoff in each of the sub-basins, on the basis of the relative magnitude of the respective dry, wet and gross drainage areas. In this way natural runoff for each of the three sub-basis was estimated for each year in the 35 year study period 1944 to 1978 inclusive.

Chapter III

WATER BALANCE AND AVAILABILITY

The quantity of water available for use in Gouverneur Reservoir depends not only on natural runoff in a given year, but also on the effect of man-made storage, including the operation of Admiral and Cadillac reservoirs, as well as on the extent of other project development upstream. This "other" development may involve, for example, the consumptive use of water through irrigation, thus reducing the quantity of water available for use downstream.

It was necessary to estimate the volume which would spill from each of Admiral and Cadillac reservoirs during each year of the 35 year study period, under varying specified levels of demand and rules of operation. Such spillage would then consititute part of the volume of annual inflow to Gouverneur Reservoir for purposes of the study. Having determined the annual inflow to each of these reservoirs under specified conditions, a draft analysis for each reservoir under these conditions could be carried out.

On Figure 2 are shown curves relating water elevation to flooded area and storage capacity for the three above-mentioned reservoirs.

A. OPERATING LEVELS

For the water balance calculations, two different minimum levels were used initially for each of the reservoirs. The

first was the dry elevation of the reservoir, allowing the maximum possible drawdown, which in the case of Admiral is probably the normally used minimum operating level.

A second and higher minimum level was used also, which in the case of Cadillac and Gouverneur would be equal, or close to, the normally used minimum operating level. By using two different minimum levels for each reservoir, some evaluation could be made on the effect of available storage on the water supply concerning the particular reservoir.

Subsequently, at the request of Water Rights Branch, a third option for minimum level was investigated for Admiral and partially investigated for Gouverneur Reservoir. This third option for minimum levels was between the two previously considered for each of these reservoirs.

The maximum operating level used in the study for each of Admiral and Gouverneur reservoirs was the designated full supply level (FSL). In the case of Cadillac Reservoir the maximum operating level used in the past, and still being used, is the crest of the spillway which is elevation 2552.0 feet (777.85m). However, the reservoir is licensed for operation at the designated FSL of 2554.0 feet (778.459m), a higher level which is actually the top of the control stop-logs. For Cadillac Reservoir it was necessary to include

both of these options in the study, since the higher level could be used as the maximum operating level in the future, and if so the reservoir storage available would be increased.

B. ADMIRAL AND CADILLAC RESERVOIRS

For a draft rate analysis of Admiral and Cadillac reservoirs three levels of upstream demand for each reservoir were supplied by Water Rights Branch, based on a water administration perspective. The first level was essentially the present upstream use or development, the second allowed for a moderate increase, and the third still higher level was considered an upper limit, or at least an optimistic view of possible project development in each sub-basin. These three levels are identified for convenient reference in the study as present, future #1, and future #2 respectively.

For each level of upstream demand the amount of draft available from the corresponding reservoir was calculated, using each of the various combinations of minimum and maximum operating levels previously outlined. These combinations amounted to nine different study cases for Admiral, and, with two options for maximum levels, to twelve study cases for Cadillac Reservoir.

In Table 2, for Admiral and Cadillac reservoirs, each study case is identified, and for each the governing conditions and

results of the study are summarized. Shown are specific values for the different levels of upstream demands, reservoir operating levels and live storage, for each study case. For cases in which the minimum operating level used is the dry elevation of the reservoir, this is also identified. The draft rate analysis included an evaluation of firm annual draft and median spillage under the various sets of imposed conditions. These results are also summarized in the tabulation.

If the level of annual withdrawal from a reservoir is equal to or less than the firm annual draft, then there should be no diversion shortage in any particular year. When the annual withdrawal is larger than the firm draft, however, shortages can be expected to occur, and the frequency of shortages will tend to increase with increasing volume of annual withdrawal.

This relationship between volume of annual withdrawal and frequency of shortage under a given combination of upstream demand and reservoir operation was investigated. Curves were drawn up summarizing the results of this investigation, and these are shown for Admiral Reservoir on Figure 3, and for Cadillac Reservoir on Figure 4. In all cases the upper ends of the curves are terminated rather sharply by a horizontal line, which indicates that the limitation of available storage has been reached. If the demand or intended withdrawal is

Table 2

FIRM DRAFT AND SPILLAGE FROM ADMIRAL AND CADILLAC RESERVOIRS UNDER GIVEN CONDITIONS

1. ENGLISH UNITS

Development	Upstream Demand (ac-ft)	Study Case No.	Full Supply Elevation (feet)	Minimum Allowable Elevation (feet)	Reservoir Live Storage (ac-ft)	Firm Draft (ac-ft)	Median Annual Spillage (ac-ft)
A. Admiral Reservoir							
Present	1370	1A	2740.6	2720[1]/	938	327	3278
		1B	2740.6	2733	633	109	3482
		1C	2740.6	2730	786	205	3525
Future #1	1620	2A	2740.6	2720	938	250	3100
		2B	2740.6	2733	633	67	3272
		2C	2740.6	2730	786	138	3336
Future #2	1870	3A	2740.6	2720	938	185	2910
		3B	2740.6	2733	633	4.4	3080
		3C	2740.6	2730	786	75	3013
B. Cadillac Reservoir							
Present	954	1A	2552	2539.0[1]/	1450	554	2984
		1B	2552	2544.5	1115	251	3274
		1C	2554	2539.0	1822	661	2850
		1D	2554	2544.5	1487	410	3090
Future #1	1126	2A	2552	2539.0	1450	459	2900
		2B	2552	2544.5	1115	192	3158
		2C	2554	2539.0	1822	562	2842
		2D	2554	2544.5	1487	313	3010
Future #2	1454	3A	2552	2539.0	1450	355	2674
		3B	2552	2544.5	1115	111	2908
		3C	2554	2539.0	1822	459	2542
		3D	2554	2544.5	1487	211	2780

[1]/ Dry elevation of given reservoir

Table 2 (Continued)

FIRM DRAFT AND SPILLAGE FROM ADMIRAL AND CADILLAC RESERVOIRS UNDER GIVEN CONDITIONS

2. METRIC UNITS

Development	Upstream Demand (dam^3)	Study Case No.	Full Supply Elevation (metres)	Minimum Allowable Elevation (metres)	Reservoir Live Storage (dam^3)	Firm Draft (dam^3)	Median Annual Spillage (dam^3)
A. Admiral Reservoir							
Present	1690	1A	835.335	829.056[1]/	1157	403	4043
		1B	835.335	833.018	781	134	4295
		1C	835.335	832.104	970	253	4348
Future #1	1998	2A	835.335	829.056	1157	308	3824
		2B	835.335	833.018	781	83	4036
		2C	835.335	832.104	970	170	4115
Future #2	2307	3A	835.335	829.056	1157	228	3589
		3B	835.335	833.018	781	5.4	3799
		3C	835.335	832.104	970	92	3716
B. Cadillac Reservoir							
Present	1177	1A	777.850	773.887[1]/	1789	683	3681
		1B	777.850	775.564	1375	310	4038
		1C	778.459	773.887	2247	815	3515
		1D	778.459	775.564	1837	506	3811
Future #1	1389	2A	777.850	773.887	1789	566	3577
		2B	777.850	775.564	1375	237	3895
		2C	778.459	773.887	2247	693	3506
		2D	778.459	775.564	1934	386	3713
Future #2	1793	3A	777.850	773.887	1789	438	3298
		3B	777.850	775.564	1375	137	4587
		3C	778.459	773.887	2247	566	3136
		3D	778.459	775.564	1834	260	3429

[1]/ Dry elevation of given reservoir

larger than the storage available in a full reservoir, then shortages can be expected to occur in 100 per cent of the years. In general these curves show the relationship between draft volume and frequency of shortage at each of the three levels of upstream demand. Shown also is the same relationship using different minimum, and in the case of Cadillac different maximum, operating levels in the reservoir.

C. GOUVERNEUR RESERVOIR

One of the factors which affects the magnitude of annual inflow to Gouverneur Reservoir is the quantity of water passing Admiral and Cadillac reservoirs. The consequences, in terms of downstream flow, of permitting different levels of upstream demand, and of using different operating levels for Admiral and Cadillac reservoirs, have been evaluated in the study cases listed in Table 2. To carry out a draft rate analysis of Gouverneur Reservoir, certain of these study cases were selected as representing significant operational options, which may affect spillage from Admiral and Cadillac reservoirs.

Selected for Admiral Reservoir were study case 3A values for upstream demand and reservoir operating levels as listed in Table 2, along with alternative draft rates of 492 acre-feet (607 dam^3) and 650 acre-feet (802 dam^3) for the respective runs.

Similarly selected for Cadillac Reservoir were study case 3B values for upstream demand and reservoir operating levels listed in Table 2, together with alternative draft rates for that reservoir at 535 acre-feet (660 dam^3) and 800 acre-feet (987 dam^3) for the respective runs.

The respective draft rates were selected generally on the basis of the draft versus shortage relationships shown on Figure 3 for Admiral, and on Figure 4 for Cadillac Reservoir. In addition, the lower of the two draft rates for Admiral represents the present demand, and that for Cadillac the demand which is possible now and which is at least foreseeable in the near future. The higher of the two draft rates, which could develop for the respective reservoirs in the future, was included in the study to test the effect that such increases would have in the water supply, both locally and downstream at Gouverneur Reservoir.

For both Admiral and Cadillac reservoirs, an annual water balance was completed for each of the given draft rates, assuming the given level of upstream demand. This gave a set of annual spillage volumes from the particular reservoir for each of the two draft alternatives. These annual spillage volumes were later used as a component of downstream inflow to Gouverneur Reservoir.

Two different levels of upstream demand for the local area above Gouverneur Reservoir were included in the study. These are listed in Table 3, along with other upstream conditions for various categories of Gouverneur Reservoir inflow. For each of these demand levels there were four different combinations of inflow, with different spillage from each of the two upstream reservoirs as outlined above, for which a draft analysis was required. In total this meant eight sets, or categories, of annual inflow to Gouverneur Reservoir for the study period, consisting of four sets for each of the two levels of upstream demand. Table 3 summarizes the upstream conditions as outlined for the various inflow categories, which were routed through Gouverneur Reservoir for a draft analysis.

For study purposes Gouverneur Reservoir was operated using FSL, as shown on Figure 2, as the maximum allowable elevation. Two different options, previously mentioned, were used for minimum reservoir level. For every set of annual inflows over the 35 year study period, a draft analysis was carried out for each of two minimum allowable levels, which were 2465 feet (751.332 metres), the dry elevation, and 2482.25 feet (756.590 metres), a higher elevation at which live storage would be reduced by 1300 acre-feet (1604 dam^3). At this higher minimum level, live storage in the reservoir would be reduced by 20 per cent.

Table 3

UPSTREAM CONDITIONS FOR VARIOUS CATEGORIES
OF GOUVERNEUR RESERVOIR INFLOW

1. ENGLISH UNITS

Admiral Reservoir (U.D.[1]/ = 1870 ac-ft) Operating Levels		Cadillac Reservoir (U.D.[1]/ = 1454 ac-ft) Operating Levels		Inflow Category	Annual Draft (acre-feet)	
Maximum (feet)	Minimum (feet)	Maximum (feet)	Minimum (feet)		Admiral Reservoir	Cadillac Reservoir
A. Gouverneur Reservoir Upstream Demand = 165 acre-feet						
2740.6	2720.0	2552.0	2544.5	A1 A2 A3 A4	492 650 650	535 535 800
B. Gouverneur Reservoir Upstream Demand = 415 acre-feet						
2740.6	2720.0	2552.0	2544.5	B1 B2 B3 B4	492 492 650 650	535 800 535 800

2. METRIC UNITS

Admiral Reservoir (U.D.[1]/ = 2306 dam^3) Operating Levels		Cadillac Reservoir (U.D.[1]/ = 1794 dam^3) Operating Levels		Inflow Category	Annual Draft (dam^3)	
Maximum (metres)	Minimum (metres)	Maximum (metres)	Minimum (metres)		Admiral Reservoir	Cadillac Reservoir
A. Gouverneur Reservoir Upstream Demand - 204 dam^3						
835.34	833.02	775.56	775.56	A1 A2 A3 A4	607 607 802 802	660 987 660 987
B. Gouverneur Reservoir Upstream Demand = 512 dam^3						
835.344	833.02	777.85	775.56	B1 B2 B3 B4	607 607 802 802	660 987 660 987

[1]/ U.D. - Upstream Demand

A third previously mentioned option for minimum reservoir level, 2479.5 feet (755.752 m), was subsequently introduced and investigated for inflow categories B3 and B4. At this minimum level, between the two previously considered, live storage in the reservoir would be reduced by 800 acre-feet (987 dam^3), or by 12 per cent of total capacity.

The median inflow to Gouverneur Reservoir for each of the various study categories is listed in Table 4, along with the firm draft calculated for each minimum level assumed in reservoir operation. The relationship between annual draft and frequency of shortage for the various categories of inflow to Gouverneur Reservoir was also investigated. Curves summarizing the results of this investigation and shown on Figure 5 give an approximate relationship for draft versus shortage within the limitations of available storage in the reservoir.

Table 4

GOUVERNEUR RESERVOIR MEDIAN INFLOW AND FIRM DRAFT
FOR DIFFERENT CATEGORIES OF UPSTREAM DEMAND AND
RESERVOIR OPERATION

1. ENGLISH UNITS

1/ Inflow Category	Median Annual Inflow (ac-ft)	Minimum Allowable Level (feet)	Firm Draft (ac-ft)	1/ Inflow Category	Median Annual Inflow (ac-ft)	Minimum Allowable Level (feet)	Firm Draft (ac-ft)
A. Local Upstream Demand=165 ac-ft				B. Local Upstream Demand=415 ac-ft			
A1	7414	2465.0 2/	1960	B1	7150	2465.0 2/	1790
		2482.25	1220			2482.25	1050
A2	7000	2465.0	1960	B2	6750	2465.0	1790
		2482.25	1220			2482.25	1050
A3	7272	2465.0	1960	B3	7022	2465.0	1790
		2482.25	1220			2479.5	1273
						2482.25	1050
A4	6874	2465.0	1960	B4	6624	2465.0	1790
		2482.25	1220			2479.5	1273
						2482.25	1050

1/ See Table 3 for upstream conditions which differentiate one inflow category from another

2/ Dry elevation of Gouverneur Reservoir

Table 4 (Continued)

GOUVERNEUR RESERVOIR MEDIAN INFLOW AND FIRM DRAFT
FOR DIFFERENT CATEGORIES OF UPSTREAM DEMAND AND
RESERVOIR OPERATION

2. METRIC UNITS

1/ Inflow Category	Median Annual Inflow (dam^3)	Minimum Allowable Level (metres)	Firm Draft (dam^3)	1/ Inflow Category	Median Annual Inflow (dam^3)	Minimum Allowable Level (metres)	Firm Draft (dam^3)
A. Local Upstream Demand=204 dam^3				B. Local Upstream Demand=512 dam^3			
A1	9145	751.332 2/	2420	B1	8819	751.332 2/	2210
		756.590	1500			756.590	1300
A2	8634	751.332	2420	B2	8326	751.332	2210
		756.590	1500			756.5905	1300
A3	8970	751.332	2420	B3	8662	751.332	2210
		756.590	1500			755.752	1570
						756.590	1300
A4	8479	751.332	2420	B4	8171	751.332	2210
		756.590				755.752	1570
						756.590	1300

1/ See Table 3 for upstream conditions which differentiate one inflow category from another

2/ Dry elevation of Gouverneur Reservoir

Chapter IV

RESULTS

A study has been carried out on the hydrology of Upper Notukeu Creek Basin, and the draft availability in Admiral, Cadillac and Gouverneur reservoirs under varying conditions. The volume of annual spill from Admiral and Cadillac reservoirs under different operation and levels of use was considered particularly, because of its possible effect downstream on the water supply for Gouverneur Reservoir.

For Admiral Reservoir the present level of upstream demand and two higher levels were considered, and for each level the live storage capacity was varied with three options for minimum reservoir elevation. With the highest of these three minimums, about one-third of the total reservoir storage would be unavailable for normal project diversion. The use of this higher value for minimum operating level, as compared to using the dry elevation, tends to increase the median annual spill, but decreases severely the volume of draft which would be available from the reservoir. For the three options in reservoir operating levels, an increase of about 36 per cent over the present upstream demand would result in a decrease in median annual spill ranging from 11 to 14.5 per cent, but the relative reduction in draft available from the reservoir would be much more severe.

Three levels of upstream demand, including the present, were also considered for Cadillac Reservoir. For each of these, reservoir operation was varied with two different minimum operating levels, the lower being the dry elevation, and two different maximum levels. Possible combinations of these operating levels gave four different live storage volumes for the reservoir, the largest of these exceeding the smallest by about 63 per cent. For a given level of upstream demand the smaller the live storage volume the smaller also the available draft, but the larger the median annual spill. With constant maximum and minimum operating levels and a 52.4 per cent increase over the present upstream demand, the study indicated about a 10 per cent decrease in median annual spill, but a decrease in firm draft ranging from 36 to 50 per cent.

The relationship between the magnitude of annual draft from each reservoir and the frequency of shortage was investigated. As the draft volume increases the frequency of shortage also tends to increase. However, at a shortage frequency of around 20 per cent (i.e., 16 to 18 per cent for Admiral and 18 to 24 per cent for Cadillac) the annual draft is approximately equal to the volume of avalable storage in the reservoir. Any increase in annual demand beyond this volume would, of course, result in a 100 per cent frequency of shortage.

For the draft study of Gouverneur Reservoir specific conditions of upstream demand and reservoir operation were selected. From the viewpoint of Gouverneur Reservoir water supply, relatively severe conditions were imposed on the two upstream reservoirs. For example the demand upstream of Admiral and Cadillac reservoirs was assumed to be Future #2 as listed in Table 2, the highest demand level included in the draft analysis of those reservoirs. In the case of Admiral Reservoir, the dry elevation was used as the minimum operating level, and this choice would also tend to minimize, other conditions being equal, the volume of spillage available downstream as inflow to Gouverneur Reservoir. Two levels of annual draft for each of Admiral and Cadillac reservoirs were included in the study, as previously outlined in Chapter III. Possible combinations of draft rates in the two upstream reservoirs resulted in the inclusion of four different sets of annual inflow to Gouverneur Reservoir.

The volume of draft available from Gouverneur Reservoir was investigated assuming two different levels of upstream demand, and three options for minimum reservoir level. It was found that the change assumed in minimum operating level for the reservoir would have a much larger effect on the size of firm annual draft available, say 70 per cent of the time, than would the various assumptions made for upstream demand and operation of Admiral and Cadillac reservoirs. For example use

of the highest value for minimum level, instead of the dry reservoir elevation, results in a decrease in firm annual draft from the reservoir of about 40 per cent.

With the same minimum and maximum operating levels in Gouverneur Reservoir, the volume of available draft is affected to some extent by the volume of local upstream demand. For example, in the study, an increase of about 152 per cent over present demand in the local upstream area resulted in a decrease in firm annual draft of about 8 and 13 per cent respectively, for two different options of minimum reservoir level.

As previously mentioned, there were variations in draft from Admiral and Cadillac reservoirs which resulted in four different inflow categories, or sets of annual inflow to Gouverneur Reservoir. The study indicated that the firm draft from Gouverneur would remain the same, despite these inflow variations, as long as there is no change in the local upstream demand or in the maximum and minimum levels used in operating Gouverneur Reservoir.

For each of the three reservoirs the study indicated that the setting of minimum or maximum operating levels which affects the volume of live storage is a very important factor in determining the magnitude of available annual draft.

Chapter V

CONCLUSIONS

From the results of this study the following conclusions can be drawn:

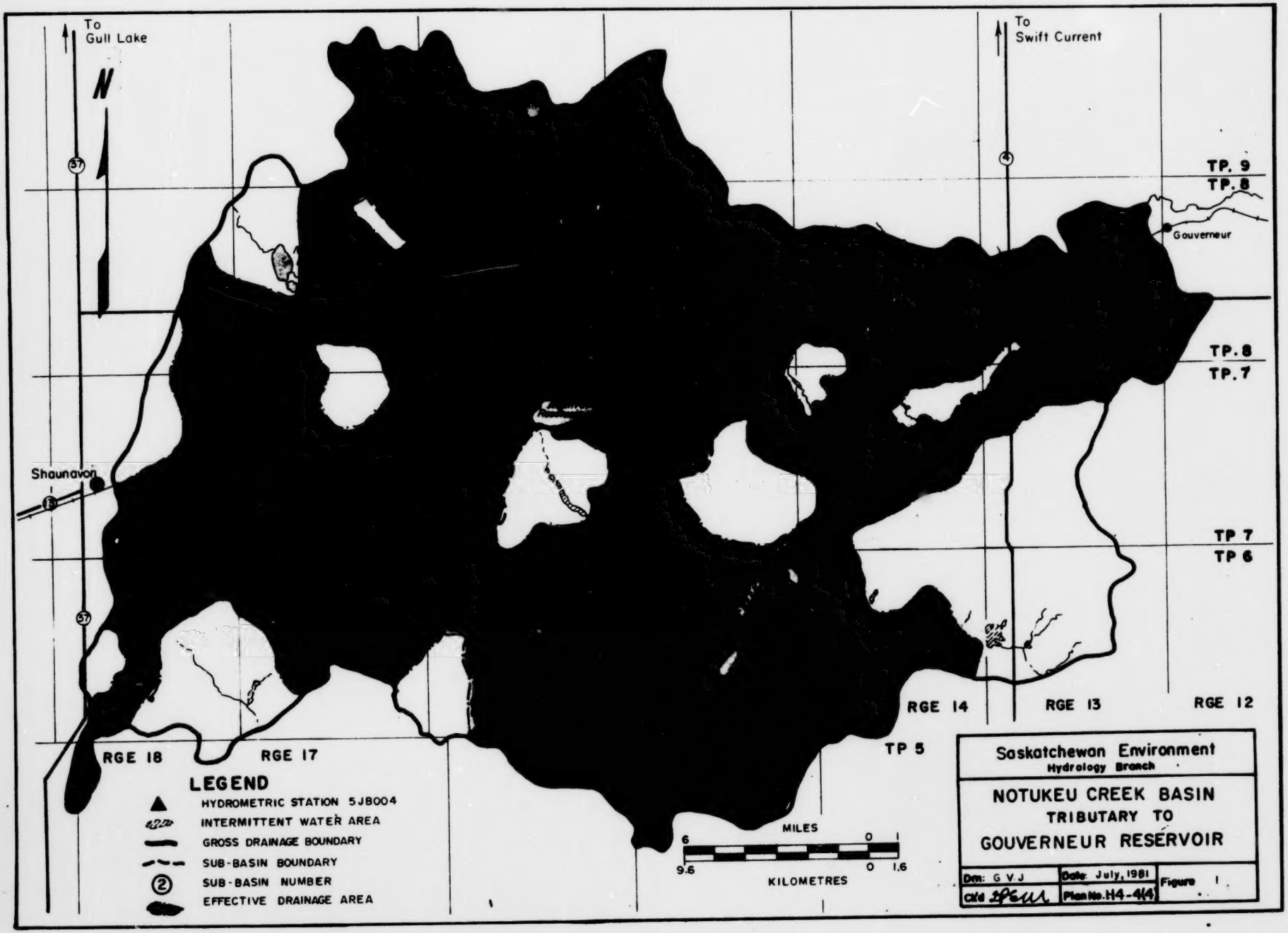
1. The water supply for Gouverneur Reservoir is not expected to be seriously affected or diminished by variation upstream in Admiral and Cadillac reservoir operation and demand, such as were considered in this study.

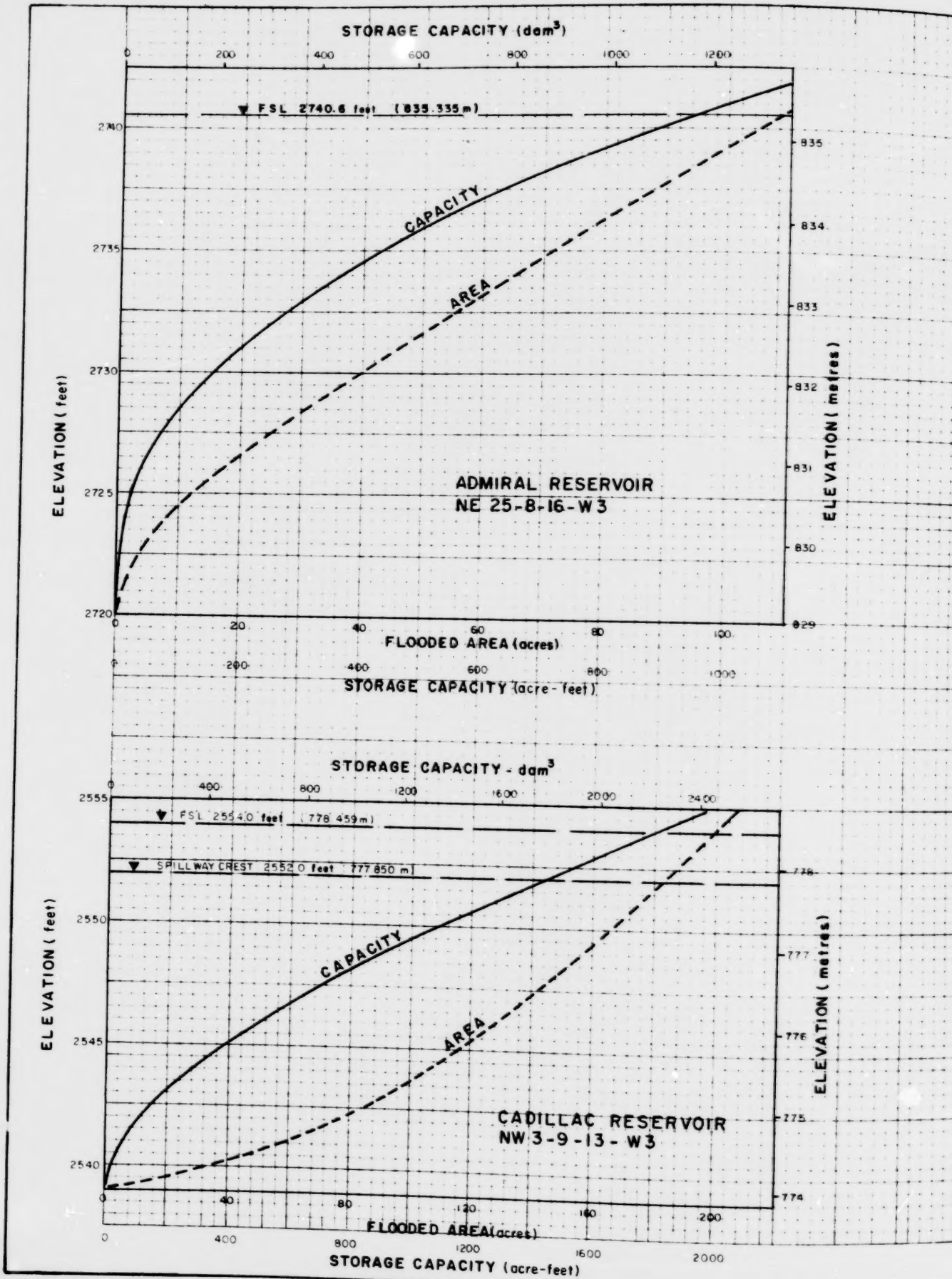
2. The live storage capacity for each of the three reservoirs, as determined by the selection of operating levels, is a major factor affecting the firm draft and draft with some shortage available from the particular reservoir.

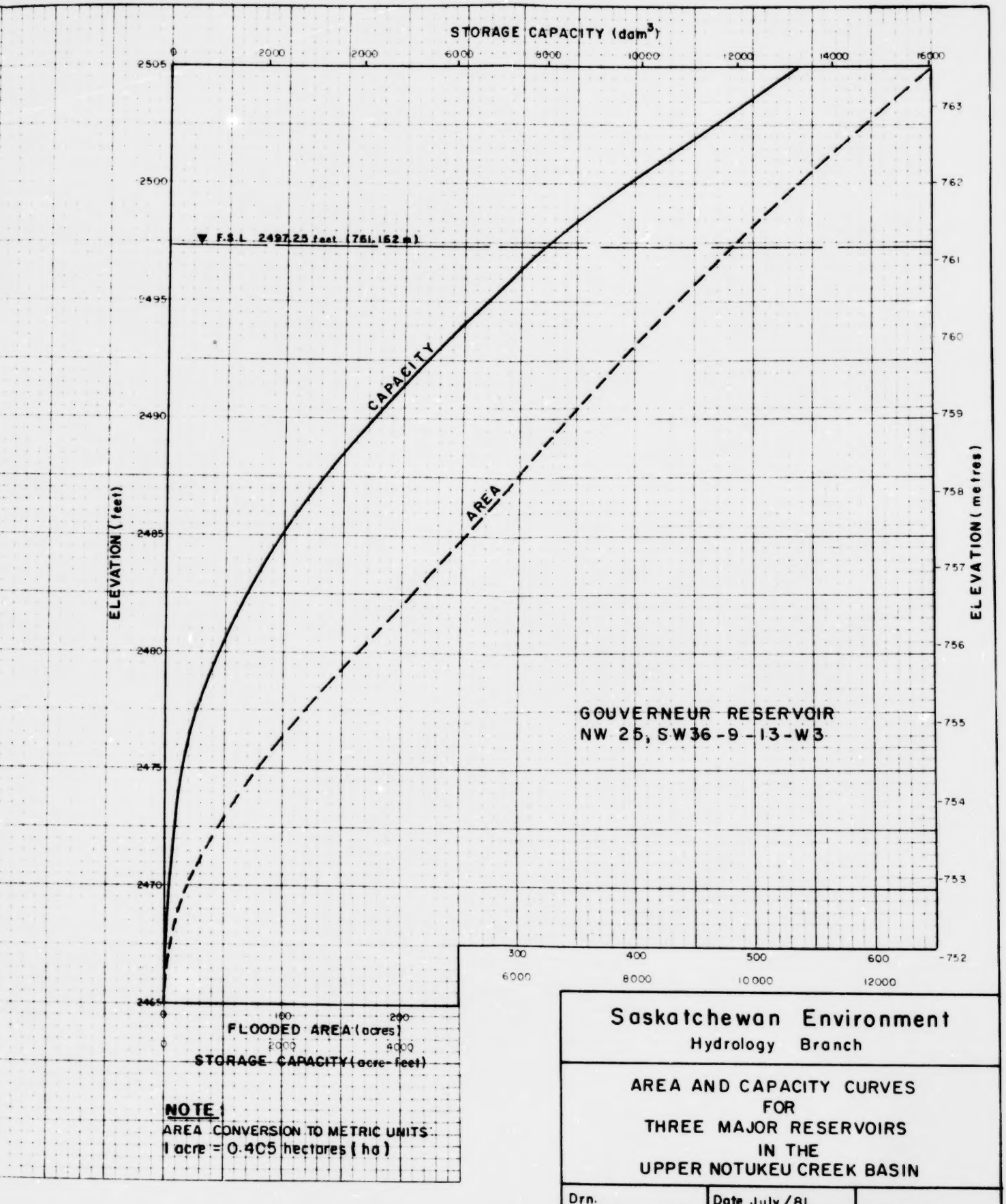
3. The water supply for all three reservoirs appears to be sufficient for increased project use. However, an increase in local upstream demand will generally result in some decrease in firm draft and in draft available with a given degree of shortage. With a given live storage capacity in the reservoir, some balance is needed between allowable upstream demand and annual draft required from the reservoir.

4. For Gouverneur Reservoir, with given minimum and maximum operating levels, firm draft appears to be limited in critical

years to runoff from the local area upstream including any effect from local upstream demand, and not on variations on use and reservoir operation considered in the study for Admiral and Cadillac reservoirs.


To
Gull Lake
N
To
Swift Current
TP. 9
TP. 8
Gouverneur
TP. 8
TP. 7
Shaunavon
TP 7
TP 6
RGE 14
RGE 13
RGE 12
RGE 18
RGE 17
TP 5
LEGEND
HYDROMETRIC STATION 5JB004
INTERMITTENT WATER AREA
GROSS DRAINAGE BOUNDARY
SUB-BASIN BOUNDARY
SUB-BASIN NUMBER
EFFECTIVE DRAINAGE AREA
MILES
6
0
1
9.6
0
1.6
KILOMETRES
Saskatchewan Environment
Hydrology Branch
NOTUKEU CREEK BASIN
TRIBUTARY TO
GOUVERNEUR RESERVOIR
Drn: G V J
Date: July, 1981
Chk'd
Plan No. H4-414
Figure 1


STORAGE CAPACITY (dam³)
0
200
400
600
800
1000
1200
FSL 2740.6 feet (835.335 m)
2740
2735
2730
2725
2720
CAPACITY
AREA
835
834
833
832
831
830
829
ELEVATION (feet)
ELEVATION (metres)
ADMIRAL RESERVOIR
NE 25-8-16-W3
0
20
40
60
80
100
FLOODED AREA (acres)
0
200
400
600
800
1000
STORAGE CAPACITY (acre-feet)
STORAGE CAPACITY - dam³
0
400
800
1200
1600
2000
2400
2555
FSL 2554.0 feet (778.459 m)
SPILLWAY CREST 2552.0 feet (777.850 m)
2550
2545
2540
CAPACITY
AREA
778
777
776
775
774
ELEVATION (feet)
ELEVATION (metres)
CADILLAC RESERVOIR
NW 3-9-13-W3
0
40
80
120
160
200
FLOODED AREA (acres)
0
400
800
1200
1600
2000
STORAGE CAPACITY (acre-feet)



NOTE:
AREA CONVERSION TO METRIC UNITS
1 acre = 0.405 hectares (ha)

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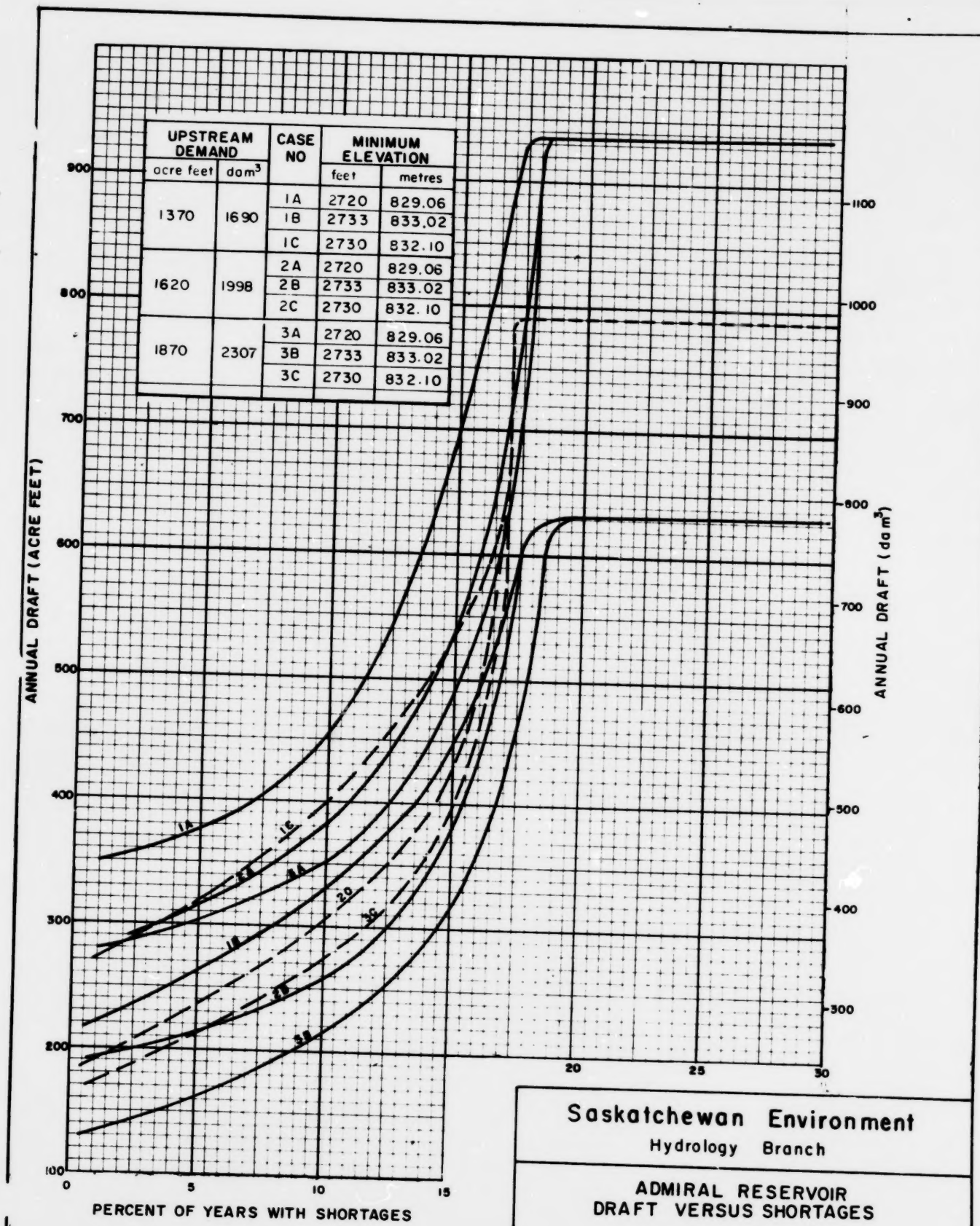
AREA AND CAPACITY CURVES
FOR
THREE MAJOR RESERVOIRS
IN THE
UPPER NOTUKEU CREEK BASIN

Drn.	Date July/81	Figure 2
Ck'd. HBM.	Plan No. H4-4(5)	



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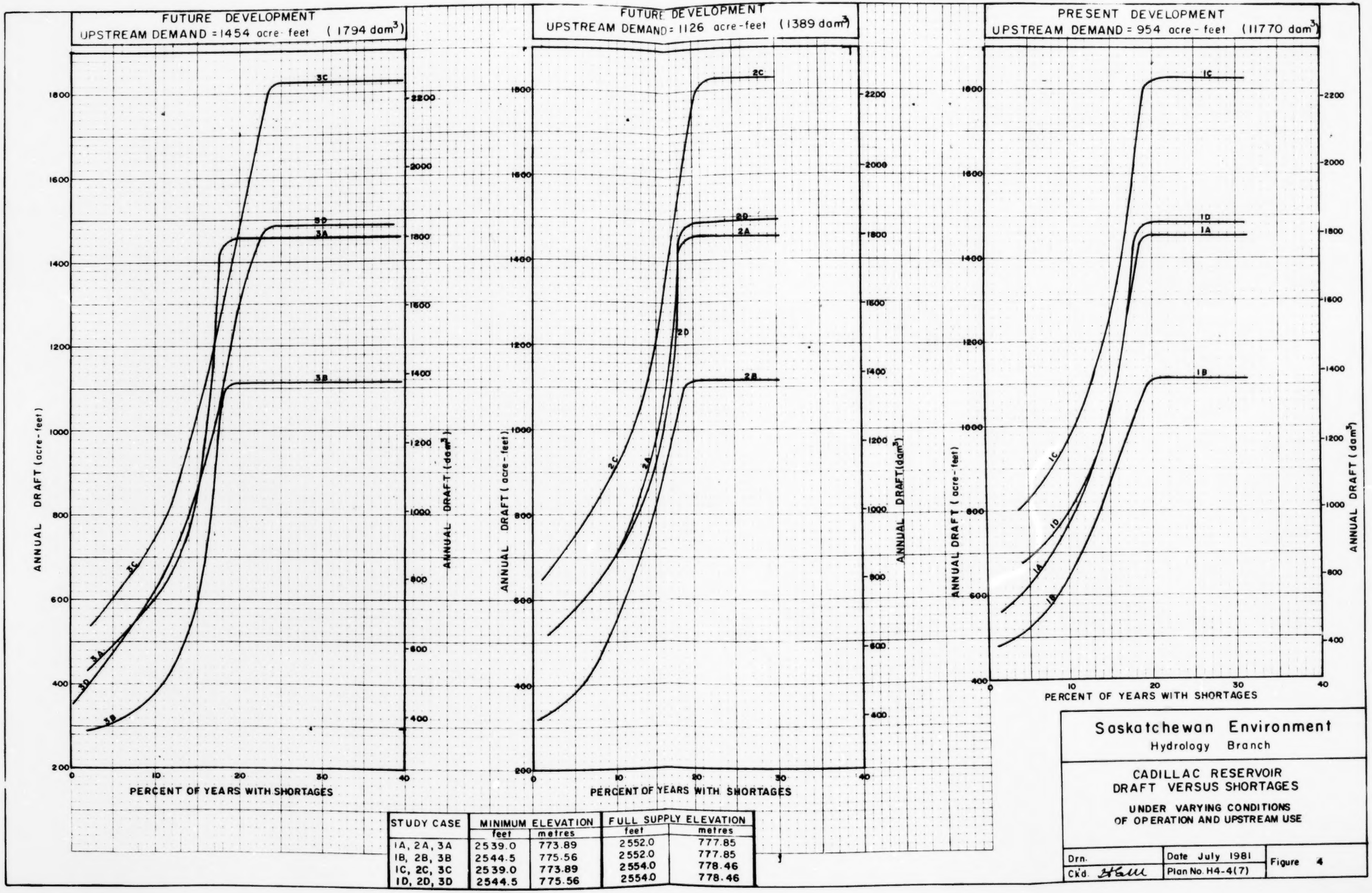
ADMIRAL RESERVOIR
DRAFT VERSUS SHORTAGES
UNDER VARYING CONDITIONS
OF OPERATION AND UPSTREAM USE

Drr.	Date: July 1981	Figure 3
Ckd.	Plan No. H4-4(6)	



STUDY CASE	MINIMUM ELEVATION		FULL SUPPLY ELEVATION	
	feet	metres	feet	metres
1A, 2A, 3A	2539.0	773.89	2552.0	777.85
1B, 2B, 3B	2544.5	775.56	2552.0	777.85
1C, 2C, 3C	2539.0	773.89	2554.0	778.46
1D, 2D, 3D	2544.5	775.56	2554.0	778.46

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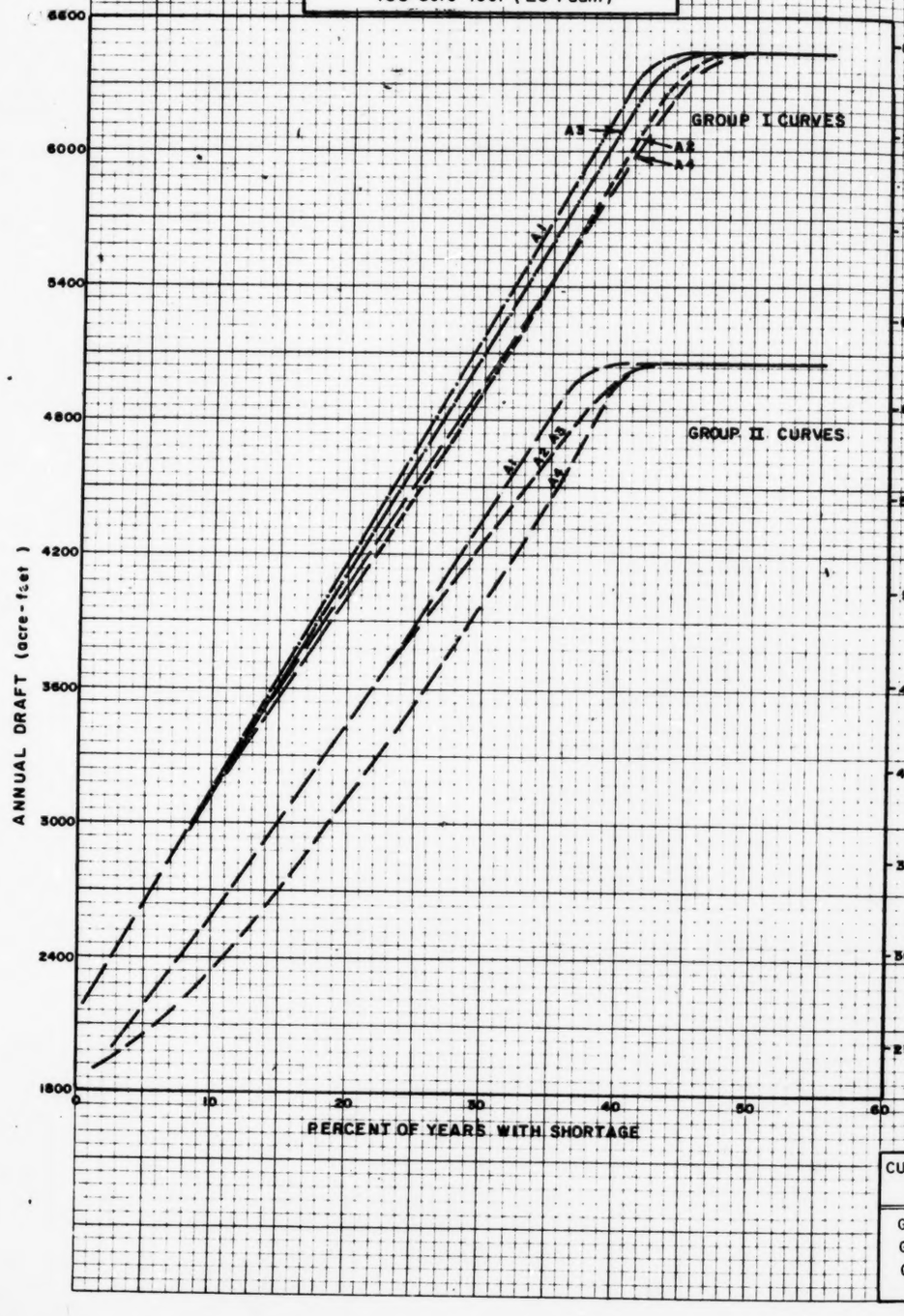
CADILLAC RESERVOIR
DRAFT VERSUS SHORTAGES

UNDER VARYING CONDITIONS
OF OPERATION AND UPSTREAM USE

Drn.	Date July 1981	Figure 4
Ck'd.	Plan No. H4-4(7)	

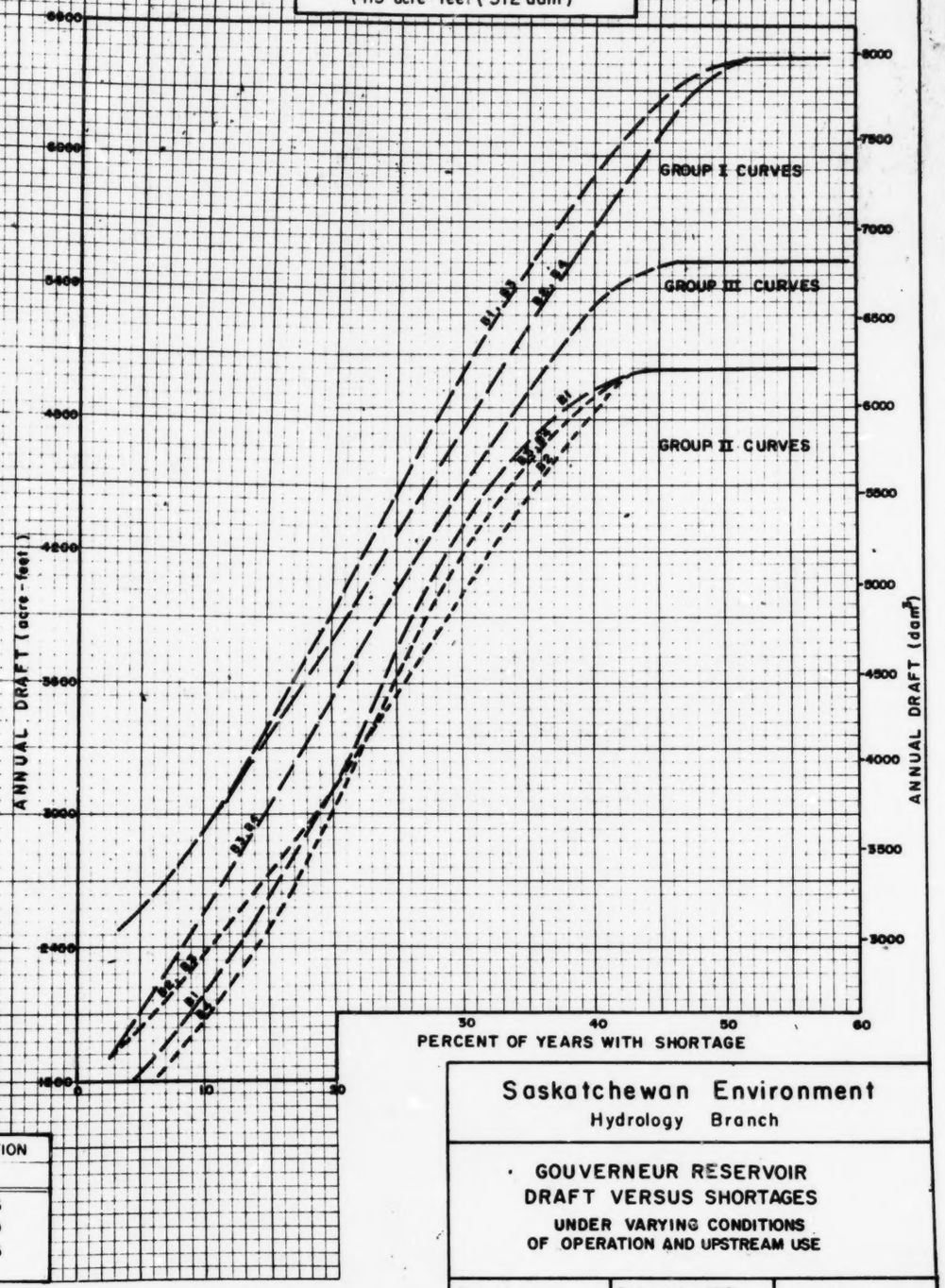
Z-02-80-52

UPSTREAM DEMAND
165 acre-feet (204 dam³)



CURVE GROUPING	MINIMUM ELEVATION	
	feet	metres
GROUP I	2465.0	751.33
GROUP II	2482.25	756.59
GROUP III	2479.5	755.75

UPSTREAM DEMAND
(415 acre-feet (512 dam³)



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GOUVERNEUR RESERVOIR
DRAFT VERSUS SHORTAGES
UNDER VARYING CONDITIONS
OF OPERATION AND UPSTREAM USE

Drn.	Date July 1981	Figure 5
Ck'd.	Plan No. H4-4(8)	

POOR

QUALITY

ORIGINAL